

## Retraction

# Retracted: Can Limits to Arbitrage Explain Stock Price Idiosyncratic Volatility Premium Puzzle in China's A-Share Market?

### Discrete Dynamics in Nature and Society

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] X. Chen and J. Ye, "Can Limits to Arbitrage Explain Stock Price Idiosyncratic Volatility Premium Puzzle in China's A-Share Market?" *Discrete Dynamics in Nature and Society*, vol. 2021, Article ID 9549366, 7 pages, 2021.

## Research Article

# Can Limits to Arbitrage Explain Stock Price Idiosyncratic Volatility Premium Puzzle in China's A-Share Market?

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Investigating the existence and causes of idiosyncratic volatility premium puzzle in developing stock market can enrich the research on this asset pricing puzzle. To investigate the existence and whether limits to arbitrage in China's A-share market can explain the idiosyncratic volatility premium puzzle, this paper uses listed stocks in China's A-share market from 2002 to 2019 as a sample. We calculate three individual measures and one comprehensive measure of limits to arbitrage based on Chinese specific regulations. After that, we conduct univariate portfolios analysis, regression analysis, and bivariate portfolios analysis to obtain evidence. We prove that idiosyncratic volatility premium puzzle exists in China's A-share market and is robust and that limits to arbitrage in this market can partly explain this asset pricing puzzle. This paper enriches research on asset pricing anomaly and can help us evaluate the effect of China's A-share market reform.

## 1. Introduction

The CAPM predicts that investors can only require compensation for bearing systematic risk because idiosyncratic risk is completely diversified away when the financial market is completely efficient. Prior studies show that investors in some markets cannot fully diversify their portfolios in practice [1]. Thus, idiosyncratic volatility (IV) will be expected to play a role in the risk-return relationship. One of the important tenets of modern portfolios theory is that systematic risk is the sole driver of returns, and thus idiosyncratic volatility cannot explain why returns of some stocks or portfolios are higher or lower than others [2]. Nevertheless, Merton [3] posited that investors cannot diversify their portfolios and require a positive risk premium for bearing idiosyncratic volatility. As a result, the relationship between idiosyncratic volatility and stock returns is positive.

However, the empirical asset pricing literature showed that the sign of the relationship between idiosyncratic volatility and stock returns is one of the most controversial

topics. First, most of these empirical studies argue that idiosyncratic volatility is not priced [4]. Second, other literature concludes that stocks with higher idiosyncratic volatility command higher risk premium [5]. Third, many works argue that the relationship between idiosyncratic volatility and stock returns is negative [6], and this implies that the average return of stocks with low (high) idiosyncratic volatility is higher (lower) than others. The lack of consensus on the sign of the idiosyncratic volatility premium is called idiosyncratic volatility premium puzzle.

Some papers investigate the existence and causes of the idiosyncratic volatility premium puzzle, but it is also necessary for us to further investigate the causes of the idiosyncratic volatility premium puzzle in China's A-share market. Gu et al. [7] use a sample containing all listed companies in Shanghai Stock Exchange and Shenzhen Stock Exchange, and the sample period spans from January 2002 to December 2012. They find that negative idiosyncratic volatility premium exists in China's A-share market and this asset pricing effect is much stronger and more persistent in stocks with high limits of arbitrage. However, many new

regulation changes have taken place in China's A-share market after 2012. One of the most important reforms is the enforcement of securities margin trading regulation. On March 30, 2010, securities margin trading regulation was enforced in some stocks in China's A-share market. During the whole year 2010, the purchasing amount of margin trading accounts for about 0.16 percent of the total trading amount in China's A-share market, and the selling amount of margin trading is zero. The number of stocks that are available for margin trading and the number of total listed companies in China's A-share market are 96 and 2041 at the end of year 2010, respectively. In addition, the margin trading activities increase quickly after 2010. During the whole year 2019, purchasing (selling) amount of margin trading accounts for about 8.94% (0.23%) of the total trading amount in China's A-share market. The number of stocks that are available for margin trading and the number of total listed companies in China's A-share market are 1761 and 3857, respectively, at the end of year 2019. During the period from 2010 to 2019, the average percentage of purchasing (selling) amount of margin trading accounts for a total trading amount of about 7.14% (0.52%). Securities margin trading is one important regulation that may have an important impact on China's A-share market. First, securities margin trading is one important factor affecting arbitraging activities, which are the main mechanism that corrects mispricing and improves capital market efficiency.

Against this background, we want to investigate two issues. First, we want to know whether the idiosyncratic volatility premium puzzle still exists in China's A-share market as that found by Gu et al. [7] using the sample during 2002 and 2012. Second, can limits to arbitrage measures related to this new background explain this asset pricing puzzle? This paper uses listed stocks in China's A-share market during 1999 and 2019 as sample to investigate the existence of idiosyncratic volatility premium puzzle in China's A-share market and whether limits to arbitrage in the new background can explain this kind of asset pricing puzzle.

## 2. Materials and Methods

**2.1. Sample.** This paper uses a panel data set consisting of all listed companies in China's A-share market. Original accounting data and stock trading data are all obtained from RESET data provider, and the variables  $R_{i,t}$ ,  $MKT_d$ ,  $SMB_d$ , and  $HML_d$  are used directly. The sample period is from January 2002 to December 2019. Financial sector companies, special treated companies, and companies with missing value are excluded from the original sample.

**2.2. Data and Descriptive Statistics.** Following Ang et al. [6], stock  $i$ 's idiosyncratic volatility in month  $t$  equals to stock  $i$ 's standard deviation of daily abnormal returns within that month to proxy for stock  $i$ 's idiosyncratic volatility in month  $t$ . Stock  $i$ 's daily abnormal returns are calculated based on Fama and French's [8] three-factor model in month  $t$ . Equation (1) is the three-factor model used to calculate individual stock's daily abnormal return.

$$R_{i,d} - rf_d = \alpha_i + \beta_i MKT_d + s_i SMB_d + h_i HML_d + \varepsilon_{i,d}. \quad (1)$$

Equation (1) is used to calculate daily abnormal return on stock  $i$  in day  $d$ , where  $R_{i,d}$  is the return on stock  $i$  in day  $d$ ,  $rf_d$  is the risk free return in day  $d$ , and  $MKT_d$ ,  $SMB_d$ , and  $HML_d$  are Fama and French's [8] three factors in day  $d$ . For each stock  $i$ , we estimate equation (1) every month and calculate daily abnormal return on stock  $i$  in day  $d$ .

The main variables used in this paper include monthly stock return ( $R_{i,t}$ ), equal to price change of stock  $i$  in month  $t$  divided by beginning price of stock  $i$  in month  $t$ ; monthly abnormal stock return ( $AR_{i,t}$ ), equal to monthly return of stock  $i$  adjusted by Fama and French's [8] three-factor model; ratio of equity divided by market value ( $BM_{i,t}$ ), equal to equity of company  $i$  at the beginning of the year divided by total market value of its common stock at the beginning of month  $t$ ; turnover ratio ( $TURN_{i,t}$ ), equal to turnover ratio of tradable common stock during the period from month  $t-5$  to month  $t$ ; mean of top 5 maximum daily returns of stock  $i$  in month  $t$  ( $MAX_{i,t}$ ), equal to mean of stock  $i$ 's top 5 highest stock returns within month  $t$ ; and firm size  $\ln MV_{i,t}$ , equal to log of total market value of common stock  $i$  at the end of month  $t$ .

Based on China's A-share market background and regulations, we design the following four variables used to measure limits to arbitrage, three of which are individual measures and the last one is a comprehensive measure which is constructed on the first three measures.

The first one is Amihud [9] illiquidity measure ( $AMH_{i,t}$ ). This measure reflects the effect of trading dollar amount on stock price. The higher value of this measure reflects less liquidity of the stock, and it is more difficult and costly for arbitragers to exploit the mispricing opportunity, and the idiosyncratic volatility premium puzzle may be more evident.

The second one is the number of daily closing prices reaching price limits in the last six months ( $PLN_{i,t}$ ). China's A-share market introduced the price limit regulation which allows for 10 percent price change in the current trading day compared with last trading day's closing price. Chen et al. [10] argue that price limit regulation hinders price discovery. By intuition, large  $PLN_{i,t}$  indicates low price efficiency; moreover, it is more difficult for arbitrageurs to correct mispricing, and the idiosyncratic volatility premium puzzle may be more significant.

The third one is the dummy variable proxy for whether margin stock trading is allowed ( $MST_{i,t}$ ). China's A-share market introduced marginal security trading regulation in 2010, but this regulation is only applied in some of the trading securities. Diamond and Verrecchia [11] believe that short selling constraints hinder price discovery; the price is more efficient in market without short selling constraints. We deduce that idiosyncratic volatility premium puzzle is more significant in stocks with short selling constraints.

The last one is comprehensive measure of limits to arbitrage which is constructed on the above three individual limits to arbitrage measures. We first construct three equal

portfolios sorted by  $AMH_{i,t}$  and  $PLN_{i,t}$  each month, respectively. Second, we use discrete variables  $D1_{i,t}$  and  $D2_{i,t}$  values of which are 0, 1, and 3, representing low, middle, and high level of limits to arbitrage stocks measured by  $AMH_{i,t}$  and  $PLN_{i,t}$ , respectively. After that, we use variable  $CM_{i,t}$  proxies for comprehensive level of limits to arbitrage. The value of  $CM_{i,t}$  equals to  $[(3 - D1_{i,t})/2 + D2_{i,t}/2 + MST_{i,t}]$ .

Table 1 reports the descriptive statistics and correlation coefficients for key variables. Panel A shows the descriptive statistics. Mean, median, and skewness of  $R_{i,t+1}$  ( $AR_{i,t+1}$ ) are 0.01 (-0.00), -0.00 (-0.01), and 0.78 (0.82), respectively. This evidence indicates that distribution of stock return in China's A-share market is right skewed. The mean values of  $IVOL_{i,t-1}$ ,  $BM_{i,t}$ , and  $TURN_{i,t}$  are all larger than the corresponding median values of these variables, and the corresponding skewness values of these variables are all positive. The mean values of  $\ln MV_{i,t}$  and  $MAX_{i,t}$  are both smaller than the corresponding median values of these variables, and the corresponding skewness values of these variables are both negative. This evidence indicates that the distributions of variables  $IVOL_{i,t-1}$ ,  $BM_{i,t}$ , and  $TURN_{i,t}$  are all right skewed, and the distributions of variables  $\ln MV_{i,t}$  and  $MAX_{i,t}$  are both left skewed. Evidence from panel A tells us that the number of lower returns is less than the number of higher returns.

Panel B shows us the Spearman and Pearson correlation coefficients of main variables. The up-right part is Spearman correlation coefficients and the down-left part is Pearson correlation coefficients. The Pearson correlation coefficients of  $IVOL_{i,t-1}$  with  $AR_{i,t+1}$  and  $R_{i,t+1}$  are -0.09 and -0.01, respectively, and both are statistically significant at 1% level. The corresponding Spearman correlation coefficients are -0.07 and -0.01, and both are statistically significant at 1% level. All these pieces of evidence primarily indicate that firms with higher idiosyncratic volatility are always followed by lower subsequent stock return. The evidence from panel B also tells us that next month's return of firms with higher book-to-market ratio and firms with higher maximum daily return is higher than that of other firms. Furthermore, returns of firms with bigger size and higher turnover are always lower than those of other firms in the nearest future month.

The analysis above tells us the basic characteristics of our sample, and the correlation analysis primarily tells us that stock price idiosyncratic volatility is negatively correlated with next month's stock return.

**2.3. Methodology.** In Section 3.1, we conduct univariate portfolios analysis and regression analysis to obtain more evidence on the existence of idiosyncratic volatility premium puzzle. We construct 5 and 10 portfolios based on  $IVOL_{i,t-1}$  and calculate equally weighted and market value-weighted mean of each portfolio's monthly return. In the regression section, we first construct one asset pricing factor  $IVOLF_{t-1}$  based on  $IVOL_{i,t-1}$ , introduce this factor into Fama and French's [8] regression, and conduct Fama and MacBeth's [12] stepwise regression. The results of these two tests are reported in Tables 2 and 3, respectively.

In Section 3.2, we conduct two tests to obtain evidence on whether limits to arbitrage can explain idiosyncratic volatility premium puzzle in China's A-share market. First, we conduct bivariate portfolio analysis based on  $IVOL_{i,t-1}$  and comprehensive measure of limits to arbitrage  $CM_{i,t}$ . Second, we conduct bivariate portfolio analysis based on  $IVOL_{i,t-1}$  and individual measures of limits to arbitrage  $AMH_{i,t}$ ,  $PLN_{i,t}$ , and  $MST_{i,t}$ . The results of these two tests are reported in Tables 4 and 5, respectively.

### 3. Results and Discussion

**3.1. Empirical Evidence on the Existence of Idiosyncratic Volatility Premium Puzzle in China's A-Share Market.** We conduct univariate portfolios analysis to obtain evidence on the existence of idiosyncratic volatility premium puzzle in China's A-share market. Each month, all the stocks are sorted into 5 and 10 equal portfolios based on  $IVOL_{i,t-1}$ , respectively. Then, we calculate equally weighted and tradable common stock market value-weighted return of each portfolio. After that, we calculate time series mean of each portfolio return and the corresponding mean return differences between extreme portfolios. Q1 (Q5) stands for portfolios with lowest (highest)  $IVOL_{i,t-1}$  when constructing five portfolios. D1 (D10) stands for portfolios with lowest (highest)  $IVOL_{i,t-1}$  when constructing 10 portfolios.

Table 2 reports equally weighted and market value-weighted time series means of each portfolio's returns, sorted by  $IVOL_{i,t-1}$ . Panel A reports returns of five portfolios sorted by  $IVOL_{i,t-1}$ . These results show that the higher (lower) the  $IVOL_{i,t-1}$ , the lower (higher) the returns of the portfolios. Equally weighted  $R_t$  ( $AR_t$ ) difference between portfolio Q1 and Q5 is 1.42 (1.51), and the corresponding  $t$ -statistics is 17.09 (24.67). The tradable common stock market value-weighted  $R_t$  ( $AR_t$ ) difference between portfolio Q1 and Q5 is 0.37 (1.39), and the corresponding  $t$ -statistics is 4.30 (20.32).

Panel B reports returns of ten portfolios sorted by  $IVOL_{i,t-1}$ . These results show that the higher (lower) the  $IVOL_{i,t-1}$ , the lower (higher) the returns of the portfolios. Equally weighted  $R_t$  ( $AR_t$ ) difference between portfolio D1 and D10 is 1.91 (2.04), and the corresponding  $t$ -statistics is 16.20 (23.17). Tradable common stock market value-weighted  $R_t$  ( $AR_t$ ) difference between portfolio D1 and D10 is 0.78 (2.16), and the corresponding  $t$ -statistics is 6.41 (21.95).

In summary, evidence from univariate portfolios analysis tells us that idiosyncratic volatility can negatively predict future stock return; the higher the  $IVOL_{i,t-1}$ , the lower the future stock return. The following regression analysis will provide us with more related evidence.

In the Section 2, we construct idiosyncratic volatility pricing factor ( $IVOLF_t$ ). The calculation process used to calculate  $VOLF_{i,t}$  asset pricing factor consists of the following three steps. First, we sort and construct five portfolios based on  $IVOL_{i,t}$  each month. Second, we calculate market value-weighted mean return of stocks in each portfolio as the return of that portfolio in that month. Third, we calculate extreme portfolios return difference ( $IVOLF_t$ ), equal to

TABLE 1: Descriptive statistics and correlation coefficients of main characteristic variables.

| Panel A: descriptive statistics of main characteristics of our sample |       |       |       |       |       |       |        |       |       |
|---|-------|-------|-------|-------|-------|-------|--------|-------|-------|
| Var   | Mean  | Medi  | Std   | Q1    | Q3    | Min   | Max    | Skew  | Kurt  |
| $AR_{i,t+1}$  | -0.00 | -0.01 | 0.10  | -0.06 | 0.05  | -1.68 | 1.22   | 0.82  | 4.82  |
| $R_{i,t+1}$   | 0.01  | -0.00 | 0.13  | -0.07 | 0.08  | -0.53 | 1.42   | 0.78  | 3.48  |
| $IVOL_{i,t}$  | 0.02  | 0.02  | 0.01  | 0.01  | 0.03  | 0.00  | 0.08   | 1.06  | 1.40  |
| $BM_{i,t}$  | 0.39  | 0.33  | 0.27  | 0.21  | 0.51  | -6.36 | 5.43   | 0.64  | 18.82 |
| $\ln MV_{i,t}$  | 21.99 | 22.04 | 1.26  | 21.23 | 22.78 | 17.46 | 28.17  | -0.05 | 0.25  |
| $TURN_{i,t}$  | 45.49 | 34.22 | 38.33 | 18.83 | 59.89 | 0.41  | 397.90 | 2.09  | 6.90  |
| $MAX_{i,t}$   | -0.16 | -0.14 | 0.09  | -0.20 | -0.10 | -0.51 | 0.50   | -1.23 | 3.56  |

  

| Panel B: correlation coefficients of main variables (up-right is Spearman, and down-left is Pearson) |              |             |              |            |                |              |             |
|--|--------------|-------------|--------------|------------|----------------|--------------|-------------|
| Var  | $AR_{i,t+1}$ | $R_{i,t+1}$ | $IVOL_{i,t}$ | $BM_{i,t}$ | $\ln MV_{i,t}$ | $TURN_{i,t}$ | $MAX_{i,t}$ |
| $AR_{i,t+1}$   | 1.00         | 0.58***     | -0.09***     | 0.04***    | -0.05***       | -0.08***     | 0.03***     |
| $R_{i,t+1}$  | 0.63***      | 1.00        | -0.01***     | 0.05***    | -0.04***       | 0.01**       | 0.01***     |
| $IVOL_{i,t}$   | -0.07***     | -0.01***    | 1.00         | -0.29***   | 0.07***        | 0.46***      | -0.53***    |
| $BM_{i,t}$   | 0.02***      | 0.03***     | -0.25***     | 1.00       | -0.07***       | -0.27***     | 0.06***     |
| $\ln MV_{i,t}$   | -0.03***     | -0.04***    | 0.07***      | -0.02***   | 1.00           | 0.00         | 0.02***     |
| $TURN_{i,t}$   | -0.05***     | 0.01**      | 0.41***      | -0.24***   | 0.01**         | 1.00         | -0.41***    |
| $MAX_{i,t}$  | 0.00**       | 0.02***     | -0.52***     | 0.06***    | 0.01**         | -0.37***     | 1.00        |

Note. \*\*, \*\*\*Statistical significance at 5% and 1% levels, respectively.

TABLE 2: Mean of equally and market value-weighted portfolios returns when sorted by  $IVOL_{i,t-1}$ .

| Panel A: equally and market value-weighted return of five equal portfolios sorted by $IVOL_{i,t-1}$ |        |         |         |         |          |          |       |           |  |
|---|--------|---------|---------|---------|----------|----------|-------|-----------|--|
| Portfolios  |        | Q1      | Q2      | Q3      | Q4       | Q5       | Q1-Q5 | $t$ -stat |  |
| Equally weighted  | $R_t$  | 1.23*** | 1.28*** | 1.18**  | 0.90***  | -0.18**  | 1.42  | 17.09     |  |
|   | $AR_t$ | 0.32**  | 0.33**  | 0.21**  | -0.09*   | -1.19*** | 1.51  | 24.67     |  |
| Market value weighted   | $R_t$  | 1.87*** | 1.97*** | 2.22*** | 2.164*** | 1.51***  | 0.37  | 4.30      |  |
|   | $AR_t$ | 0.97*** | 0.78**  | 0.93*** | 0.66**   | -0.42*** | 1.39  | 20.32     |  |

  

| Panel B: equally and market value-weighted returns of ten equal portfolios sorted by $IVOL_{i,t-1}$ |        |         |         |         |      |         |         |      |         |          |          |        |           |
|---|--------|---------|---------|---------|------|---------|---------|------|---------|----------|----------|--------|-----------|
| Portfolios  |        | D1      | D2      | D3      | D4   | D5      | D6      | D7   | D8      | D9       | D10      | D10-D1 | $t$ -stat |
| Equally weighted  | $R_t$  | 1.19*** | 1.27*** | 1.28*** | 1.29 | 1.25**  | 1.11**  | 1.06 | 0.73*   | 0.35**   | -0.72*** | 1.91   | 16.20     |
|   | $AR_t$ | 0.31*** | 0.33*** | 0.33*** | 0.33 | 0.26*** | 0.16**  | 0.10 | -0.27   | -0.65*** | -1.73*** | 2.04   | 23.17     |
| Market value weighted   | $R_t$  | 1.69*** | 2.07*** | 1.60*** | 2.33 | 2.44*** | 1.99*** | 2.20 | 2.12*** | 2.04***  | 0.91**   | 0.78   | 6.41      |
|   | $AR_t$ | 0.92*** | 1.03*** | 0.50*   | 1.07 | 1.14*** | 0.71**  | 0.73 | 0.60*   | 0.32*    | -1.24*** | 2.16   | 21.95     |

Note. \*, \*\*, \*\*\*Statistical significance at 10%, 5%, and 1% levels, respectively.

TABLE 3: Fama and MacBeth [12] regression results.

|            | Equal weight       |                    | Market value weighted |                    |
|------------|--------------------|--------------------|-----------------------|--------------------|
| Intercept  | 0.003*** (6.83)    | 0.001 (1.38)       | 0.007*** (16.03)      | 0.003*** (3.98)    |
| IVOLF      |                    | -0.013*** (-4.50)  |                       | -0.306*** (-4.67)  |
| MKT        | 0.985*** (98.24)   | 0.972*** (90.32)   | 0.977*** (88.22)      | 0.957*** (79.51)   |
| SMB        | 0.777*** (54.30)   | 0.748*** (40.66)   | 0.717*** (45.48)      | 0.683*** (33.84)   |
| HML        | -0.257*** (-14.60) | -0.262*** (-14.76) | -0.351*** (-17.11)    | -0.353*** (-17.24) |
| Adj_ $R^2$ | 49.230             | 50.791             | 47.950                | 49.931             |

Note. \*\*\*Statistical significance at 1% level.

return of the largest  $IVOL_{i,t}$  portfolio minus return of the lowest  $IVOL_{i,t}$  portfolio in each month. Furthermore, we define  $IVOLF_t$  as the idiosyncratic volatility asset pricing factor. We introduce this  $IVOLF$  into Fama and French's [8] three-factor asset pricing model and conduct Fama and MacBeth's [12] regression to test the asset pricing effect of the  $IVOLF$ . The corresponding stepwise regression results are presented in Table 3.

Table 3 reports the Fama and MacBeth [12] stepwise regression results. We can see that the estimated regression coefficients of  $IVOLF$  in equally weighted and market

value-weighted regression results are  $-0.01$  and  $-0.31$ , respectively, and both are significant at 1% level. What is more, changes of intercept ( $Adj\_R^2$ ) before and after the introduction of  $IVOLF$  in equally weighted and market value-weighted regression results are 0.00 (1.56%) and 0.00 (1.98%), respectively. All these pieces of evidence above show us that idiosyncratic volatility factor has a significant asset pricing effect.

In summary, the evidence from the descriptive, correlation, and regression analysis proves that stock price idiosyncratic volatility can negatively predict future stock

TABLE 4: Mean returns of each portfolio sorted by  $CM_{i,t}$  and  $IVOL_{i,t-1}$ .

|                       | CM            | Return     | D1    | D2    | D3    | D4    | D5    | D6    | D7    | D8    | D9    | D10   | D1-D10 | T     |
|-----------------------|---------------|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|
| Equally weighted      | L- $CM_{i,t}$ | $R_{i,t}$  | 1.58  | 1.70  | 1.73  | 1.66  | 1.82  | 1.78  | 1.76  | 1.61  | 1.54  | 1.01  | 0.57   | 2.97  |
|                       |               | $AR_{i,t}$ | 0.63  | 0.68  | 0.75  | 0.68  | 0.82  | 0.80  | 0.75  | 0.63  | 0.51  | -0.06 | 0.68   | 4.97  |
|                       | M- $CM_{i,t}$ | $R_{i,t}$  | 0.91  | 1.10  | 1.21  | 1.21  | 1.11  | 1.14  | 0.86  | 0.68  | 0.61  | -0.02 | 0.93   | 4.62  |
|                       |               | $AR_{i,t}$ | 0.10  | 0.28  | 0.38  | 0.28  | 0.21  | 0.19  | -0.09 | -0.28 | -0.31 | -1.04 | 1.15   | 7.69  |
|                       | H- $CM_{i,t}$ | $R_{i,t}$  | 0.66  | 0.58  | 0.72  | 0.71  | 0.58  | 0.40  | -0.04 | -0.08 | -0.67 | -1.51 | 2.17   | 10.27 |
|                       |               | $AR_{i,t}$ | -0.23 | -0.40 | -0.30 | -0.34 | -0.44 | -0.54 | -1.04 | -1.10 | -1.67 | -2.55 | 2.31   | 14.23 |
| Market value weighted | L- $CM_{i,t}$ | $R_{i,t}$  | 1.88  | 1.89  | 2.83  | 2.21  | 2.45  | 2.69  | 2.73  | 2.33  | 2.59  | 2.40  | -0.53  | -0.66 |
|                       |               | $AR_{i,t}$ | 0.73  | 0.79  | 1.63  | 0.98  | 1.25  | 1.35  | 1.37  | 1.12  | 1.21  | 0.59  | 0.14   | 0.96  |
|                       | M- $CM_{i,t}$ | $R_{i,t}$  | 1.67  | 1.68  | 2.04  | 2.37  | 2.02  | 2.13  | 1.71  | 1.73  | 1.95  | 1.753 | -0.08  | -0.39 |
|                       |               | $AR_{i,t}$ | 1.23  | 0.93  | 0.99  | 1.08  | 1.06  | 0.77  | 0.20  | 0.22  | 0.19  | -0.46 | 1.69   | 10.37 |
|                       | H- $CM_{i,t}$ | $R_{i,t}$  | 1.52  | 1.48  | 2.68  | 2.29  | 1.86  | 1.85  | 1.96  | 2.06  | 1.46  | 0.21  | 1.31   | 5.91  |
|                       |               | $AR_{i,t}$ | 0.61  | 0.34  | 1.19  | 0.79  | 0.64  | 0.49  | 0.29  | 0.21  | -0.12 | -2.19 | 2.81   | 15.33 |

TABLE 5: Return differences between extreme  $IVOL_{i,t-1}$  portfolios within different portfolios sorts by individual limits to arbitrage measure.

| Panel A: equally weighted extreme portfolios' mean return differences |            |              |              |              |              |              |              |
|---|------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Individual limits to arbitrage measures                               |            | AMH $_{i,t}$ |              | PLN $_{i,t}$ |              | MST $_{i,t}$ |              |
| Level of limits to arbitrage  | Returns    | P1-P10       | t-statistics | P1-P10       | t-statistics | P1-P10       | t-statistics |
| Lowest  | $R_{i,t}$  | 0.85         | 4.14         | 0.51         | 2.97         | 1.45         | 5.58         |
|   | $AR_{i,t}$ | 1.05         | 7.09         | 0.68         | 5.41         | 1.74         | 8.14         |
| Middle  | $R_{i,t}$  | 1.44         | 7.12         | 1.34         | 6.42         |              |              |
|   | $AR_{i,t}$ | 1.46         | 9.83         | 1.31         | 8.42         |              |              |
| Highest   | $R_{i,t}$  | 2.37         | 11.77        | 2.43         | 10.63        | 2.60         | 5.26         |
|   | $AR_{i,t}$ | 2.54         | 16.11        | 2.39         | 14.05        | 3.04         | 8.18         |

  

| Panel B: market value equally weighted extreme portfolios' mean return differences |            |              |              |              |              |              |              |
|--|------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Individual limits to arbitrage measures  |            | AMH $_{i,t}$ |              | PLN $_{i,t}$ |              | MST $_{i,t}$ |              |
| Level of limits to arbitrage   | Returns    | P1-P10       | t-statistics | P1-P10       | t-statistics | P1-P10       | t-statistics |
| Lowest   | $R_{i,t}$  | -1.30        | -5.77        | -0.44        | -2.76        | -0.15        | -0.52        |
|  | $AR_{i,t}$ | 0.26         | 1.56         | 0.29         | 2.22         | 1.09         | 4.41         |
| Middle   | $R_{i,t}$  | -0.60        | -2.80        | 0.90         | 3.96         |              |              |
|  | $AR_{i,t}$ | 0.71         | 4.33         | 0.78         | 4.29         |              |              |
| Highest  | $R_{i,t}$  | 1.49         | 7.05         | 2.68         | 10.57        | 0.51         | 0.89         |
|  | $AR_{i,t}$ | 3.25         | 18.25        | 2.53         | 12.77        | 5.12         | 11.53        |

return in China's A-share market. In the following section, we will conduct bivariate analysis to obtain evidence on whether limits to arbitrage can explain idiosyncratic volatility premium puzzle in China's A-share market.

3.2. Empirical Evidence on Whether Limits to Arbitrage Can Explain Idiosyncratic Volatility Premium Puzzle in China's A-Share Market. We perform bivariate sorts on  $CM_{i,t}$  and  $IVOL_{i,t-1}$  to obtain evidence on whether limits to arbitrage can explain idiosyncratic volatility premium puzzle in China's A-share market. In each month, we first constructed low, middle, and high level of limits to arbitrage portfolios sorted by  $CM_{i,t}$ , and the three portfolios are indicated by L- $CM_{i,t}$ , M- $CM_{i,t}$ , and H- $CM_{i,t}$ , respectively. Second, we constructed ten portfolios sorted by  $IVOL_{i,t-1}$  within each  $CM_{i,t}$  portfolio every month. D1 (D10) stands for portfolios with lowest (highest)  $IVOL_{i,t-1}$  when constructing 10 portfolios. After this, we constructed thirty portfolios each month. Third, we calculate equally weighted and market value-weighted mean of  $R_{i,t}$  and  $AR_{i,t}$  of the thirty portfolios each month. At last, we calculate the time series mean of equally weighted and market value-weighted

return of each portfolio and the time series mean of equally weighted and market value-weighted return difference between extreme portfolios. The results are presented in Table 4.

We can see that the equally weighted mean differences of  $R_{i,t}$  ( $AR_{i,t}$ ) between extreme portfolios within low (L- $CM_{i,t}$ ), middle (M- $CM_{i,t}$ ), and high (H- $CM_{i,t}$ ) level of limits to arbitrage portfolios are 0.57 (0.68), 0.93 (1.15), and 2.17 (2.31), and all the differences are statistically significant. What is more, means of  $R_{i,t}$  and  $AR_{i,t}$  are inclined to decrease with the increase of  $IVOL_{i,t-1}$ , in general. This tendency is more evident in portfolios with the highest level of limits to arbitrage. For example, in high level of limits to arbitrage portfolios, the means of  $AR_{i,t}$  from portfolio D1 to portfolio D10 are -0.23, -0.40, -0.30, -0.34, -0.44, -0.54, -1.04, -1.10, -1.67, -2.55, respectively.

We can also find that the market value-weighted mean differences of  $R_{i,t}$  ( $AR_{i,t}$ ) between extreme portfolios within low, middle, and high level of limits to arbitrage portfolios are -0.53 (0.14), -0.08 (1.69), and 1.31 (2.81). Except -0.53 and -0.08, all the other differences are statistically significant. This evidence indicates that means of  $R_{i,t}$  and  $AR_{i,t}$  are inclined to decrease with the increase of  $IVOL_{i,t-1}$ , but this

TABLE 6: Extended periods' mean return difference of each extreme IVOL portfolio within different portfolios sorts by individual limits to arbitrage measure.

| Returns | $CR_{i,t+2}$  | $CR_{i,t+3}$  | $CR_{i,t+4}$  | $CR_{i,t+5}$  | $CR_{i,t+6}$  | $CR_{i,t+7}$  |
|---------|---------------|---------------|---------------|---------------|---------------|---------------|
| L-CM    | -0.86*        | -1.00*        | -1.49         | -1.06         | -0.45         | -0.55         |
| M-CM    | 0.56**        | 0.89*         | 1.19*         | 2.08**        | 3.26***       | 4.27***       |
| H-CM    | 3.03***       | 3.51***       | 4.99***       | 6.92***       | 8.06***       | 9.97***       |
| H-L     | 3.89***       | 4.51***       | 6.48***       | 7.97***       | 8.51***       | 10.51***      |
| Returns | $CAR_{i,t+2}$ | $CAR_{i,t+3}$ | $CAR_{i,t+4}$ | $CAR_{i,t+5}$ | $CAR_{i,t+6}$ | $CAR_{i,t+7}$ |
| L-CM    | 0.23          | 0.14          | -0.19         | -0.050        | 0.229*        | -0.107        |
| M-CM    | 2.76***       | 3.59***       | 4.46***       | 4.98***       | 6.272***      | 7.184***      |
| H-CM    | 4.79***       | 5.23***       | 6.88***       | 8.44***       | 10.04***      | 11.09***      |
| H-L     | 4.57***       | 5.09***       | 7.07***       | 8.49***       | 9.82***       | 11.19***      |

Note. \*, \*\*, \*\*\*Statistical significance at 10%, 5%, and 1% levels, respectively.

trend is only prevalent in stocks with high level of limits to arbitrage.

In summary, evidence from Table 4 confirms that stock price idiosyncratic volatility in the past few months can negatively predict future month stock return. This predictability is more prevalent in stocks with high level of limits to arbitrage.

To confirm the robustness of the above conclusions, we replace  $CM_{i,t}$  with each individual measure of limits to arbitrage and conduct bivariate portfolios analysis. The extreme  $IVOL_{i,t-1}$  portfolios return differences are reported in Table 5.

When limits to arbitrage are measured by  $AMH_{i,t}$ ,  $PLN_{i,t}$  and  $MST_{i,t}$  respectively, the equally weighted  $R_{i,t}$  ( $AR_{i,t}$ ) differences between extreme  $IVOL_{i,t-1}$  portfolios are 0.85 (1.05), 0.51 (0.68), and 1.45 (1.74) in the lowest level of limits to arbitrage portfolios, and the values of equally weighted  $R_{i,t}$  ( $AR_{i,t}$ ) differences between extreme  $IVOL_{i,t-1}$  portfolios are 2.37 (2.54), 2.43 (2.39), and 2.60 (3.04) in the highest level of limits to arbitrage portfolios.

When limits to arbitrage are measured by  $AMH_{i,t}$ ,  $PLN_{i,t}$  and  $MST_{i,t}$  respectively, the market value-weighted  $R_{i,t}$  ( $AR_{i,t}$ ) differences between extreme  $IVOL_{i,t}$  portfolios are -1.30 (0.26), -0.43 (0.29), and -0.15 (1.09) in the lowest level of limits to arbitrage portfolios, and the values of equally weighted  $R_{i,t}$  ( $AR_{i,t}$ ) differences between extreme  $IVOL_{i,t}$  portfolios are 1.49 (3.25), 2.68 (2.53), and 0.51 (5.12) in the highest level of limits to arbitrage portfolios.

The evidence from Tables 4 and 5 tells us that returns of the lowest  $IVOL_{i,t-1}$  portfolios minus return of the highest  $IVOL_{i,t-1}$  portfolio are always negative, especially in stocks with high level of limits to arbitrage, and this result is robust. This indicates that idiosyncratic volatility premium puzzle exists in Chinese A stock market, and this effect is more evident in stocks confronting high level of limits to arbitrage.

**3.3. Robust Test: Extended Return Period.** Table 6 shows us cumulative return ( $CR_{i,t+n}$ ) and cumulative abnormal return ( $CAR_{i,t+n}$ ) difference between extreme  $IVOL_{i,t-1}$  portfolios within low, middle, and high level of limits to arbitrage portfolios when limits to arbitrage measure are  $CM_{i,t}$  and the return periods covered are extended from two to seven months after the portfolios are constructed ( $n$  equals 2 to 7

and indicates the number of months after the portfolios are constructed).

When the time period covered is from 2 months to 7 months, the extreme  $IVOL_{i,t-1}$  portfolios  $CR_{i,t}$  differences are -0.86, -1.00, -1.49, -1.06, -0.45, and -0.5 in low level of limits to arbitrage portfolios, and the corresponding  $CAR_{i,t}$  differences are 3.03, 3.51, 4.99, 6.92, 8.06, and 9.97 in high level of limits to arbitrage portfolios. When the time period covered is from 2 months to 7 months, the extreme  $IVOL_{i,t-1}$  portfolios  $CAR_{i,t}$  differences are 0.23, 0.14, -0.19, -0.05, 0.23, and -0.11 in low level of limits to arbitrage portfolios, and the corresponding  $CAR_{i,t}$  differences are 4.79, 5.23, 6.88, 8.44, 10.04, and 11.09 in portfolios with the highest level of limits to arbitrage.

In summary, the evidence from Table 6 confirms that the idiosyncratic volatility premium puzzle is robust when extending return periods, and it is likely that the longer the return periods, the more prevalent the idiosyncratic volatility premium puzzle; this tendency is most evident in stocks confronting highest level of limits to arbitrage.

## 4. Conclusions

This paper proves that idiosyncratic volatility premium puzzle exists during the periods from 2002 to 2019 in the context of China's A-share market after controlling for size, book-to-market, and systematic risk factors. This effect is robust when we extend the return periods from two months to seven months. When we construct proxies for limits to arbitrage based on Chinese special stock market regulation, we also prove that this idiosyncratic volatility premium puzzle is more prevalent in stocks that are more difficult to arbitrage, which is consistent with the viewpoint that asset pricing puzzle can be explained by limits to arbitrage.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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